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Description of two new species of *Simulium* (*Gomphostilbia*) (Diptera: Simuliidae) from Darjeeling, India

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Abstract: *Simulium* (*Gomphostilbia*) *williei* sp. nov. and *S.* (*G.*) *sachini* sp. nov. are described on the basis of pupal and/or larval specimens collected from Darjeeling in the northeastern sub-Himalayan region of India. *Simulium* (*G.*) *williei* sp. nov. is characterized by the pupal gill composed of an inflated horn-like structure bearing eight slender thread-like filaments, and *S.* (*G.*) *sachini* sp. nov. is characterized by the pupal gill of inflated Y-form with six short finger-like projections and eight slender thread-like filaments.

Key words: black fly, *Gomphostilbia*, *Simulium*, Simuliidae, India

The subgenus *Gomphostilbia* Enderlein of the genus *Simulium* Latreille is represented in Darjeeling in the northeastern sub-Himalayan region of India by three species: *S.* (*G.*) *darjeelingense* Datta, *S.* (*G.*) *metatarsale* Brunetti, and *S.* (*G.*) *tenuistylum* Datta (Brunetti, 1911; Datta, 1973). We collected two new species of this subgenus, which are easily distinguished from most known species including the three species from Darjeeling by having the pupal gill composed of inflated structure bearing eight thread-like filaments.

In this paper, we describe these two species on the basis of pupal and/or larval specimens collected from Darjeeling, and tentatively place them in the *batoense* species-group of the subgenus *Gomphostilbia*.

The terms for morphological features used here follow those of Takaoka (2003). All the type specimens are deposited at Postgraduate Department of Zoology, Darjeeling Government College, Darjeeling, West Bengal, India.

Simulium (*Gomphostilbia*) *williei* Takaoka and Thapa sp. nov.

DESCRIPTION. **Pupa**. Body length 2.8 mm. ***Head***. Lost. ***Thorax***. Integument (Fig. 1A) yellow to yellowish-brown, moderately covered with round tubercles, with 3 simple long trichomes with coiled or uncoiled apices dorsomedially, 2 simple trichomes (1 long and with coiled apex, 1 medium-long and with uncoiled apex) anterolaterally, 1 simple long trichome with uncoiled apex posterolaterally, and 2 simple trichomes with uncoiled apices (1 long, 1 medium-long) ventrolaterally on each side. Gill (Fig. 1A, B) composed of 1 inflated horn-like structure bearing 8 slender thread-like filaments, of which 6 arising from inner surface near base, 1 medially from dorsoinner surface, and 1 subapically from dorsoinner surface; inflated horn-like structure (about 1 mm long) directed somewhat upward and forward, then curved downward and forward, with 10–12 annular constrictions, increasing in diameter from base to basal 1/4, nearly subequal medially and then decreasing apically, bearing nipple-like apex; cuticle of inflated horn-like structure light brown except basal portion blackish dorsally, very thick except somewhat

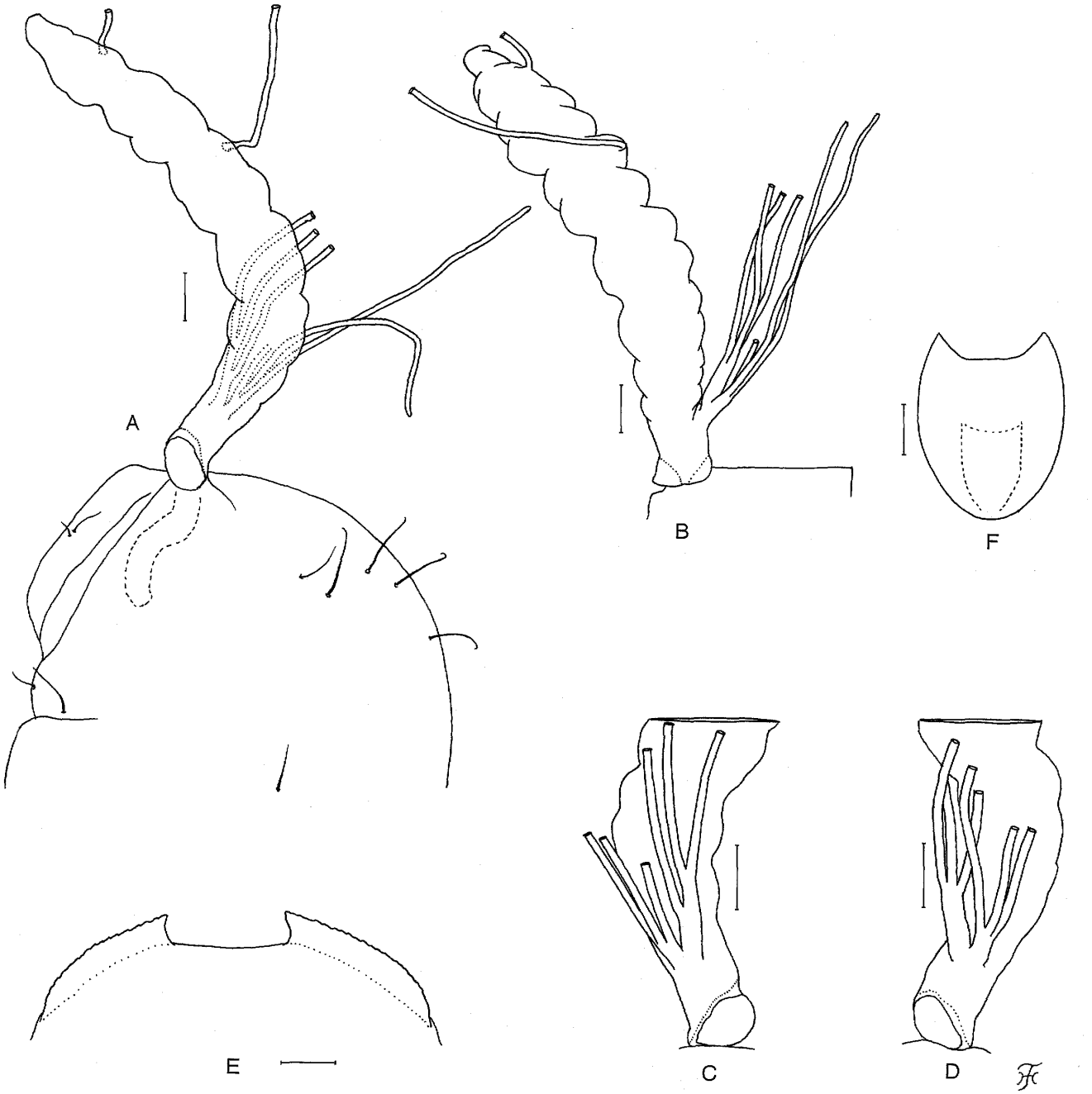

Fig. 1. Pupa of *Simulium* (*Gomphostilbia*) *williei* sp. nov. A, gill and anterior part of thorax (left side and outer view); B, gill (left side and dorsal view); C and D, basal portion of 6 gill filaments arising near base (inner view; C, left side; D, right side); E, terminal hooks (end view); F, cocoon (dorsal view). Scale bars. 1.0 mm for F; 0.1 mm for A–D; 0.02 mm for E.

swollen thin transparent organ ventrally (mostly broken) at base, with surface almost smooth though appearing to be densely covered with very minute tubercles interspersed with transparent very minute cone-shaped projections; 6 thread-like filaments (Fig. 1C, D) arising near base arranged in 2 groups (upper and lower triplets) very close together; each triplet group with 3 individual filaments arising at same level from short stalk except lower triplet group of left gill composed of 1 individual and 2 paired filaments; all thread-like filaments light brown, subequal in length (0.7–0.9 mm) and thickness to one another [except apical portion of 2 isolated filaments (1 subapical and 1 middle) lost, thus exact length not measurable]; cuticle of filaments without annular ridges though bearing annular furrows irregularly near base, and densely covered with very minute tubercles. ***Abdomen***. Dorsally,

segments 1 and 2 light yellow, without tubercles; other segments almost transparent; segment 1 with 1 medium-long simple seta on each side; segment 2 with 1 medium-long simple seta and 5 very short setae submedially on each side; segments 3 and 4 each with 4 hooked spines and 1 very short seta on each side; segment 5 lacking spine-combs; segments 6–8 each with spine-combs in transverse row and comb-like groups of minute spines on each side; segment 9 with pair of distinct plate-like broad terminal hooks with crenulated outer margin (Fig. 1E) and comb-like groups of minute spines. Ventrally, segment 4 with 1 simple hook and few very short setae on each side; segment 5 with pair of bifid hooks submedially and few simple slender very short setae on each side; segments 6 and 7 each with pair of bifid inner and simple or bifid outer hooks somewhat spaced from each other and few simple slender very short setae on each side; segments 4–8 each with comb-like groups of minute spines. Each side of segment 9 with 3 distinct grapnel-shaped hooklets. ***Cocoon*** (Fig. 1F). Wall-pocket shaped, moderately and neatly woven, extending ventrolaterally; anterior margin thickly woven; floor roughly woven; some individual threads barely visible; 3.8 mm long by 2.9 mm wide.

Mature larva. Body length 5.0–5.8 mm. Body grayish except posterior abdominal segments ocherous dorsally. Cephalic apotome yellow, sparsely covered with simple minute setae; head spots faintly positive or indistinct. Lateral surface of head capsule whitish-yellow except eye-spot region whitish; eyebrow indistinct; spots near posterior margin faintly positive. Ventral surface of head capsule (Fig. 2A) yellow except basal area near each lateral margin of postgenal cleft darkened; transverse spot on each side of postgenal cleft faintly positive. Antenna composed of 3 segments and apical sensillum, somewhat longer than stem of labral fan; proportional lengths of 1st, 2nd, and 3rd segments 1.00 : 0.90–1.06 : 0.65–0.76. Labral fan with 22 or 23 main rays. Mandible (Fig. 2B) with 3 comb-teeth, of which 1st tooth longest, 2nd tooth as long as 3rd one; mandibular serration composed of 2 teeth (1 medium-sized, 1 small); major tooth at acute angle against mandible on apical side; supernumerary serrations absent. Hypostoma (Fig. 2C) with row of 9 apical teeth; median and each corner tooth prominent, subequal in length to each other, and much longer than 3 intermediate teeth on each side; lateral margin smooth; 4 or 5 hypostomal bristles per side, lying parallel to or slightly divergent posteriorly from lateral margin. Postgenal cleft (Fig. 2A) moderately constricted basally, widest medially, deep, approaching but not reaching posterior border of hypostoma. Cervical sclerite composed of 2 small elliptical pieces, not fused to occiput, widely separated medially from each other. Histoblast of pharate gill (Fig. 2D) composed of 1 inflated structure with 8 slender thread-like filaments. Thorax and abdominal segments almost bare except abdominal segments 5–8 very sparsely covered with very minute simple and branched (bifid or trifid) almost colorless setae on dorsal and dorsolateral surface; last segment moderately covered with simple colorless minute setae on each side of anal sclerite. Rectal scales absent. Rectal papilla compound, each of 3 lobes with 6–8 finger-like secondary lobules. Anal sclerite of usual X-form, with anterior arms nearly as long as posterior ones, broadly sclerotized at base; accessory sclerite absent; basal juncture area with no sensilla. Last abdominal segment expanded ventrolaterally forming double bulges on each side, visible as large conical ventral papilla when viewed from side. Posterior circlet with 76–82 rows of up to 13 hooklets per row.

Female and **male**. Unknown.

TYPE SPECIMENS. Holotype pupa, collected from a moderately flowing trickle (width 12–13 cm, depth 2–3 cm, water temperature 15–16℃, shaded with small grasses, altitude 2,354 m, 27°23′25.3″N, 88°25′68.5″E), Dali, Darjeeling, India, 28. VI. 2009, by S. Thapa. Paratypes. 2 mature larvae, same data and date as those of the holotype.

ECOLOGICAL NOTES. The pupa and larvae of this new species were collected from small stones and pebbles in the water. Associated species were *S.* (*G.*) *sachini* sp. nov., *S.* (*G.*) *tenuistylum* Datta, *S.* (*Montisimulium*) *dasguptai* Datta, *S.* (*M.*) sp. (probably *taktsangense* Takaoka and Somboon), *S.* (*Nevermannia*) *gracile* Datta and *S.* (*N.*) *feuerborni* species-group spp. (*S.* (*N.*) *praelargum* Datta and a few other related species).

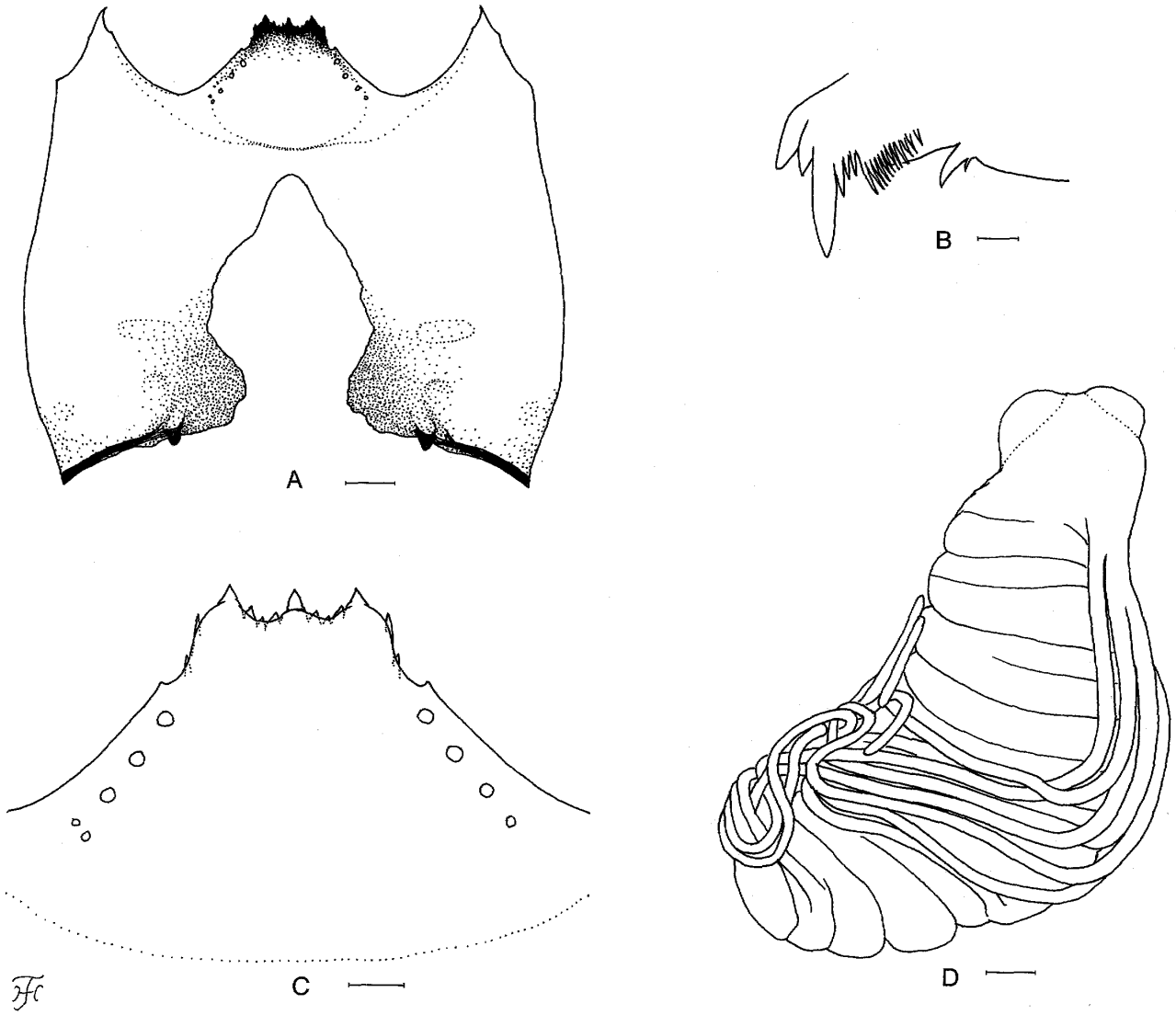

Fig. 2. Mature larva of *Simulium* (*Gomphostilbia*) *williei* sp. nov. A, head capsule showing postgenal cleft (ventral view); B, mandible; C, hypostoma; D, histoblast of pharate pupal gill (right side and outer view). Scale bars. 0.1 mm for A; 0.04 mm for D; 0.02 mm for C; 0.01 mm for B.

ETYMOLOGY. The species name *williei* is in honor of Prof. Willie Henry, Postgraduate Department of Zoology, Darjeeling Government College, for his support of this study.

REMARKS. *Simulium* (*Gomphostilbia*) *williei* sp. nov. is assigned to the subgenus *Gomphostilbia* in that it has several diagnostic characteristics of this subgenus, such as grapnel-shaped hooklets and plate-like terminal hooks (Fig. 1E) in the pupa and main tooth of the mandibular serrations at an acute angle against the mandible (Fig. 2B) and hypostoma with smooth lateral margins (Fig. 2C) in the larva. This new species is distinctive in having the inflated horn-like structure bearing eight slender filaments (Fig. 1A, B). *Simulium* (*G.*) *padangense* from Sumatra (Takaoka and Sigit, 1997) seems to be somewhat related to this new species in that it has a similar pupal gill, which is, though, composed of an inflated structure bearing seven slender filaments.

Simulium (*Gomphostilbia*) *sachini* Takaoka and Henry sp. nov.

DESCRIPTION. **Pupa.** Body length 3.0 mm. ***Head.*** Integument dark yellow, densely and neatly covered with round tubercles; frons

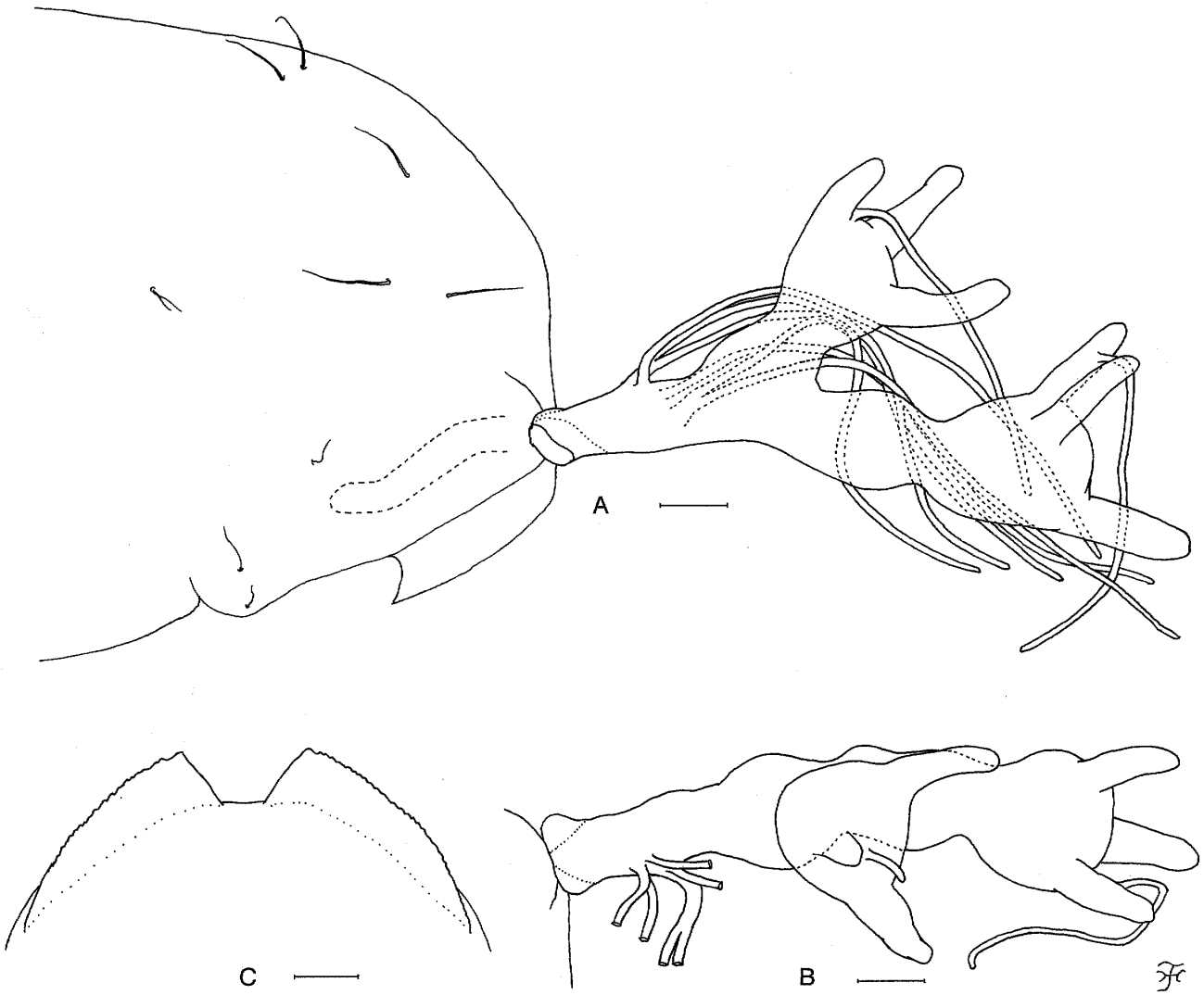

Fig. 3. Pupa of *Simulium* (*Gomphostilbia*) *sachini* sp. nov. A, gill and anterior part of thorax (right side and outer view); B, gill (left side and dorsal view); C, terminal hooks (end view). Scale bars. 0.1 mm for A and B; 0.02 mm for C.

with 3 simple long trichomes on each side; face with 1 simple long trichome on each side; frontal trichomes slightly longer than facial ones. ***Thorax***. Integument (Fig. 3A) dark yellow, moderately covered with round tubercles, with 3 simple long trichomes with coiled or uncoiled apices dorsomedially, 2 simple long trichomes with uncoiled apex anterolaterally, 1 simple or bifid long trichome with uncoiled apex posterolaterally, and 3 simple trichomes with uncoiled apices (1 medium-long, 2 short) ventrolaterally on each side. Gill (Fig. 3A,B) of inflated Y-form in lateral view (1.0 mm long), each arm with 3 short finger-like projections and 1 thread-like filament (0.5 mm long); in addition, 6 slender thread-like filaments (2 individual and 4 paired filaments, arranged as 1+2+1+2 from dorsal to ventral) arising near base from inside surface; all 6 thread-like filaments subequal in length (0.8–0.9 mm) and thickness to one another; dorsal inflated arm with 1 constriction near base, forward arm with 2 constrictions (1 basally, 1 medially); cuticle of inflated structure grayish except basal portion blackish dorsally, very thick except somewhat swollen thin transparent organ ventrally (mostly broken) at base; cuticle of 8 thread-like filaments as well as that of inflated structure smooth and densely covered with very minute tubercles. ***Abdomen***. As in *S.* (*G.*) *williei* sp. nov. except segment 9 with transverse row of spine-combs though somewhat smaller in size than those on segments 6–8 in addition to pair of distinct plate-like broad terminal hooks (Fig. 3C) and comb-like groups of minute spines. ***Cocoon***. Similar to that of *S.* (*G.*) *williei* sp.

nov.; 3.3 mm long by 2.8 mm wide.

Female, **male** and **larva**. Unknown.

TYPE SPECIMENS. Holotype pupa, same data as noted under *S.* (*G.*) *williei* sp. nov., but different date 2. VIII. 2009. Paratype. 1 pupa (right half of thorax lost), same data and date as those of the holotype.

ECOLOGICAL NOTES. As noted under *S.* (*G.*) *williei* sp. nov.

ETYMOLOGY. The species name *sachini* is in honor of Mr. Sachin Thapa, Postgraduate Department of Zoology, Darjeeling Government College, who collected this new species.

REMARKS. The remarkable configuration of the pupal gill of *S.* (*G.*) *sachini* sp. nov. (Fig. 3A, B) appears to be very similar to that of *S.* (*G.*) *gombakense* originally described from Peninsular Malaysia (Takaoka and Davies, 1995; Takaoka, 2000) and later recorded from Thailand (Kuvangkadilok and Takaoka, 2000). However, this new species is distinguished from the latter by the following characteristics (those of *S.* (*G.*) *gombakense* in parentheses): frontal and facial trichomes simple (bifid or trifid), dorsal and forward inflated arms with one and two constrictions respectively (Fig. 3A) (no and one constriction), six slender filaments near the base arranged as 1+2+1+2 from dorsal to ventral (arranged as 1+2+3) and spine-combs on the abdominal segment 9 present (absent).

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